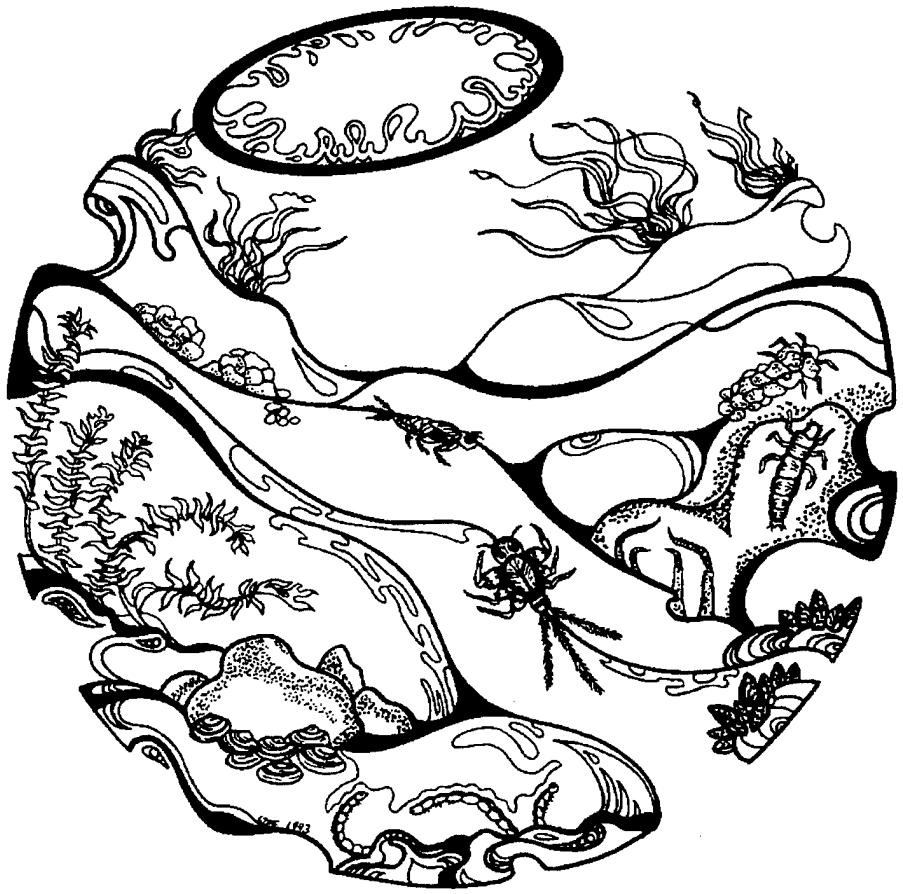
Long Term Resource Monitoring Program

Program Report
99-P001

Mayflies (Ephemeroptera) and Fingernail Clams (Sphaeriidae) at Selected Sites in the Upper Mississippi River System



February 1999

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by

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Preface

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Upper Midwest Environmental Sciences Center (formerly Environmental Management Technical Center), a U.S. Geological Survey science center, in cooperation with the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information for maintaining the UMRS as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

This report supports Task 2.2.7.4, *Evaluate and Summarize Annual Results*, as specified in Goal 2 of the LTRMP Operating Plan (U.S. Fish and Wildlife Service 1993). This report was developed with funding provided by the Long Term Resource Monitoring Program.

Mayflies (Ephemeroptera) and Fingernail Clams (Sphaeriidae) at Selected Sites in the Upper Mississippi River System

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Jennifer S. Sauer

Abstract

As part of the Long Term Resource Monitoring Program (LTRMP) macroinvertebrate component, historical sites (sites where benthic samples were previously collected by other researchers) were sampled in 1992 through 1998. Historical data on densities of the taxa were obtained from published literature and compared to data collected by the LTRMP. Temporal trends and spatial distribution in the abundance of mayflies (Ephemeroptera) and fingernail clams (Sphaeriidae) were examined in Navigation Pools 4, 8, 13, 26, and the Open River reach of the Mississippi River and La Grange Pool of the Illinois River.

Introduction

Macroinvertebrate sampling on the Upper Mississippi River System (UMRS) has a rich history. Records of sampling date back to the 1800s (Hart 1895). Mayflies and fingernail clams are important components of the aquatic food web—Thompson (1973) found that in fall, lesser scaup (*Aythya affinis*) gizzards contained 76% sphaeriids and about 13% mayflies. Thompson also found both organisms important to canvasbacks (*A. valisneria*), ring-necked ducks (*A. collaris)*, and American coots (*Fulica americana*) feeding in open water. Many commercial and recreational fish utilize both organisms (Hoopes 1960; Jude 1968; Ranthum 1969). Mayflies and fingernail clams have also traditionally been used as biological indicators of river water quality (Fremling 1964, 1973, 1989; Rosenberg and Resh 1993; Steingraber and Weiner 1995). Macroinvertebrates also perform an important ecological function by digesting organic material and recycling nutrients (Reice and Wohlenberg 1992).

The objective of this report is to document long-term patterns in mayfly and fingernail clam abundance from selected sites within the UMRS.

Methods

In 1992, macroinvertebrate sampling was initiated in six study areas on the UMRS. The six Long Term Resource Monitoring Program (LTRMP) study areas represent the variety of aquatic areas within the UMRS. They range in size (calculated from Geographic Information System coverages; Lowenberg 1993) from Pool 8 (19,000 ha) to the Open River (107,000 ha). Study areas of the LTRMP are referred to herein according to the navigation pool designations of the U.S. Army Corps of Engineers lock and dam system: Pools 4 (Mississippi River mile 752 to 797), 8 (679 to 703), 13 (523 to 557), 26 (202 to 242), and the Open River reach (29 to 80) of the Mississippi River; and La Grange Pool (Illinois River mile 80 to 158) of the Illinois River (Figure 1).

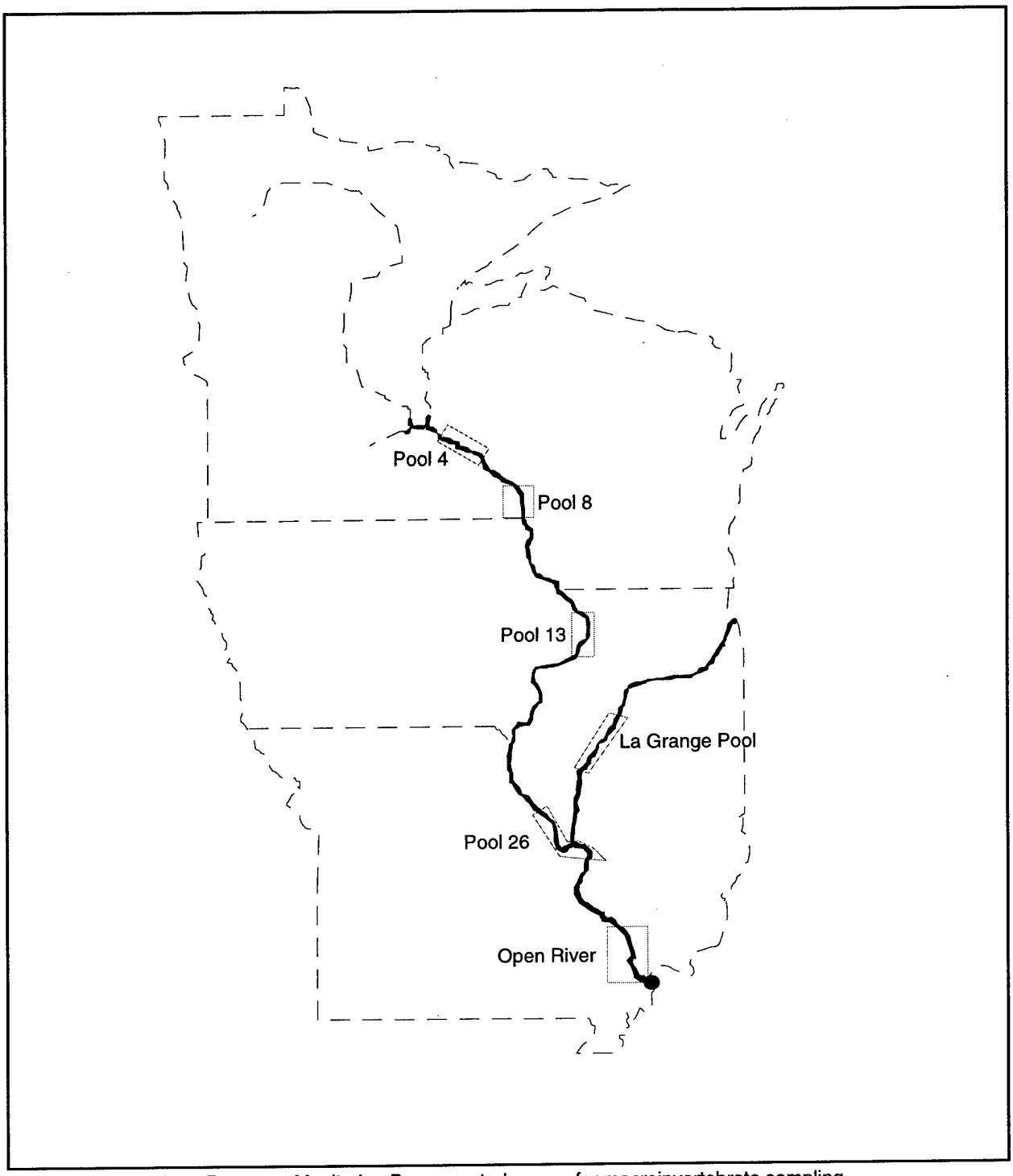

Figure 1. Long Term Resource Monitoring Program study areas for macroinvertebrate sampling.

In addition to the stratified random sampling of the LTRMP macroinvertebrate component (Thiel and Sauer 1995), part of the sampling scheme included historical sites, that is, sites where benthic samples were previously collected by other researchers (Paloumpis and Starrett 1960; North Star Research Institute 1973;

Emge et al. 1974; Colbert et al. 1975; Anderson 1977; Elstad 1977; Hubert et al. 1983; Brewer 1992; Appendix). The present report describes data from samples taken at the historical sites.

Macroinvertebrate sampling procedures are described in detail in the LTRMP Procedures Manual (Thiel and Sauer 1995). Benthic samples were collected with a winch-mounted 0.052-m^2 standard Ponar grab sampler (Ponar Grab Dredge, Wildlife Supply Company, Saginaw, Michigan). To increase sorting efficiency in the field, the wash frame sieve size was changed from a U.S. Standard Sieve No. 30 (595 μm), used in 1992, to a U.S. Standard Sieve No. 16 (1.18 mm) in 1993. Thus, inferences in macroinvertebrate numbers made from these data are restricted to the larger organisms of the population (Dukerschein et al. 1996). Mayflies (Ephemeroptera), fingernail clams (Sphaeriidae), midges (Chironomidae), Asiatic clams (*Corbicula* sp.), and zebra mussels (*Dreissena polymorpha*) were picked and counted in the field. The present report describes only mayfly and fingernail clam data. Density was recorded for each target taxa from individual Ponar samples. Whenever a taxon was not caught in a sample, the catch for that taxon in that sample was recorded as zero.

Researchers have used a variety of methods to sample macroinvertebrates (Table 1). For comparison, abundance data were converted to individuals per square meter. Abundance data were not statistically analyzed for differences between years because of the small sample size (Table 2). Table 3 lists the sampling period for each year.

Results

Pool 4

The highest number of mayflies and fingernail clams reported by North Star Research Institute (1973) were at sample sites 502 and 503 in Pool 4 (Figures 2 and 3), where he reported 105.8 m^2 mayflies and 86.5 m^2 fingernail clams. Between 1992 and 1998, the highest densities of mayflies and fingernail clams were 576.9 m^{-2} (site 504; backwater contiguous [BWC]) and 230.8 m^{-2} (site 501; tributary delta lake [TDL]), respectively. Over the years, the general distribution of mayflies was highest at sample site 504—BWC aquatic area; mayfly densities have been increasing at this site. Fingernail clam distribution was highest at the TDL aquatic area.

Pool 8

The highest number of mayflies and fingernail clams reported by Elstad (1977) at sample sites in Pool 8 (Figures 4–7), corresponding to LTRMP sites, was 1,353.5 m^{-2} and 5,184.9 m^{-2}, respectively. At most sample sites, the abundances of mayflies and fingernail clams have never rebounded to the numbers seen by Elstad in the 1970s. Brewer (1992) noted significant declines in total macroinvertebrate abundance in open water habitats and no significant changes in marsh, channel, and dredge areas. The highest density of mayflies found by Brewer was 241.3 m^{-2}, and the highest density of fingernail clams was 243.5 m^{-2}. Between 1992 and 1998, the highest densities of mayflies and fingernail clams were 1,038.5 m^{-2} and 365.4 m^{-2}, respectively. Over the years, the general distribution of mayflies was highest at sample sites 502, 504–506, 510, and 514—BWC and impounded area (IMP) aquatic areas. Fingernail clam distribution was highest at the IMP aquatic area. The IMP aquatic areas seem to have more favorable habitat for fingernail clams; that is, areas that are less stagnant and generally have more flow than the BWC aquatic areas.

Table 1. Macroinvertebrate sampling methods by various researchers at selected sites in the Upper Mississippi River System.

Pool 4 - North Star Research Institute 1973

- 2 Ponar grabs collected and contents pooled
- No. 40 soil sieve size (425 μm)
- Purpose of the transects was to provide comparative sampling locations within and between pools
- Sampling period spring and summer 1973
- 4 sites resampled for the Long Term Resource Monitoring Program (LTRMP)

Pool 8 - Elstad 1977

- 1 dredge haul (0.023 m^2)
- No. 30 sieve size (595 μm)
- 41 sampling areas chosen, 2 main channel areas and 39 adjacent waters; transects run east–west
- Sampling period 15 June to 15 July 1975
- 16 sites resampled for the LTRMP

Pool 8 - Brewer 1992

- 2 Petite Ponar dredge hauls combined (0.046 m^2)
- No. 30 sieve size (595 μm)
- Resampled Elstad's sites
- Sampling period 21 June to 13 July 1990
- 16 sites resampled for the LTRMP

Pool 13 - Hubert 1983

- 1 Peterson dredge (0.092 m^2); 3 replicates at each site pooled
- Sieve (0.5 mm)
- 6 habitat types chosen for sampling (main channel, main channel border, tail water, side channel, lakes, and sloughs)
- Sampling period 26 February to 6 March 1983
- 7 sites resampled for the LTRMP

Pool 26 - Seagle and Zumwalt 1981

- 1 Ponar grab (0.052 m^2)
- No. 30 sieve size (595 μm)
- Above wing dam
- Sampling period April 1981
- 1 site resampled for the LTRMP

Pool 26 - Colbert et al. 1975

- 2 Peterson or Ponar grabs
- No. 30 sieve size (595 μm)
- 4 habitat types sampled (main channel, side channel, main channel border, main channel border influenced by dikes); transects run
- Sampling period 2–12 July 1974
- 6 sites resampled for the LTRMP

Open River - Emge et al. 1974

- 2 Peterson dredge hauls collected and contents pooled (0.16 m^2)
- No. 30 sieve size (595 μm)
- Side channels and main channel border sampled
- Sampling period late June 1972 or July 1973
- 18 sites resampled for the LTRMP

La Grange Pool - Paloumpis and Starrett 1960

- Ekman dredge 6 × 6 inches
- No. 30 sieve size (595 μm)
- Lake Matanzas and Quiver Lake; 1952–54
- 22 sites resampled for the LTRMP

La Grange Pool - Anderson 1977

- Ekman dredge 6 × 6 inches
- No. 30 sieve size (595 μm)
- August through September 1975
- 4 sites resampled for the LTRMP

Table 2. Number of macroinvertebrate sample sites by study area and year.

Study area and year	Number of historical sites sampled
Pool 4	
1973	4[a]
1992	4
1993	4
1994	4
1995	4
1996	4
1997	4
1998	4
Pool 8	
1975	16[a]
1990	16
1992	16
1993	16
1994	16
1995	16
1996	16
1997	16
1998	16
Pool 13	
1983	7[a]
1992	7
1993	7
1994	7
1995	7
1996	7
1997	7
1998	7
Pool 26	
1974	7[a]
1981	1[a]
1992	7
1993	3[b]
1994	7
1995	0[b]
1996	7
1997	0[b]
1998	7
Open River	
1973	18[a]
1992	4[b]
1993	0[b]
1994	15[b]
1995	9[b]
1996	18
1997	0[b]
1998	18
La Grange Pool	
1952–53	22[a]
1975	4[a]
1992	23
1993	26
1994	25
1995	26
1996	26
1997	26
1998	26

[a]Number of sites chosen from research project for Long Term Resource Monitoring Program macroinvertebrate sampling.
[b]Sample sites low because of flooding.

Table 3. Sampling dates for macroinvertebrate sampling.

Study area and year	Sampling period
Pool 4	
1973	Spring and summer
1992	June 13–30
1993	May 3–14
1994	May 2–10
1995	May 3–11
1996	May 9–15
1997	May 8–13
1998	May 4–13
Pool 8	
1975	June 15–July 15
1991	June 21–July 13
1992	June 15–26
1993	May 24–June 10
1994	May 23–June 6
1995	May 22–June 2
1996	May 20–29
1997	May 27–June 2
1998	April 30–May 11
Pool 13	
1983	February 26–March 6
1992	June 2–23
1993	April 12–June 1
1994	May 10–June 1
1995	May 11–19
1996	May 31–June 6
1997	May 19–23
1998	May 11–20
Pool 26	
1974	July 2–12
1981	April
1992	June 2–26
1993	April 12–June 10
1994	May 10–31
1995	May 11–19
1996	May 9–15
1997	—[a]
1998	May 18–27
Open River	
1972–73	June 1972 or July 1973
1992	June 1–12
1993	—
1994	April 4–12
1995	April 3–17
1996	March 27–April 5
1997	—
1998	May 26–June 3
La Grange Pool	
1952–53	Spring and summer
1975	August–September
1992	June 8–24
1993	April 28–May 12
1994	May 2–12
1995	May 1–10
1996	May 6–15
1997	April 29–May 8
1998	May 4–18

[a]Not sampled because of flooding.

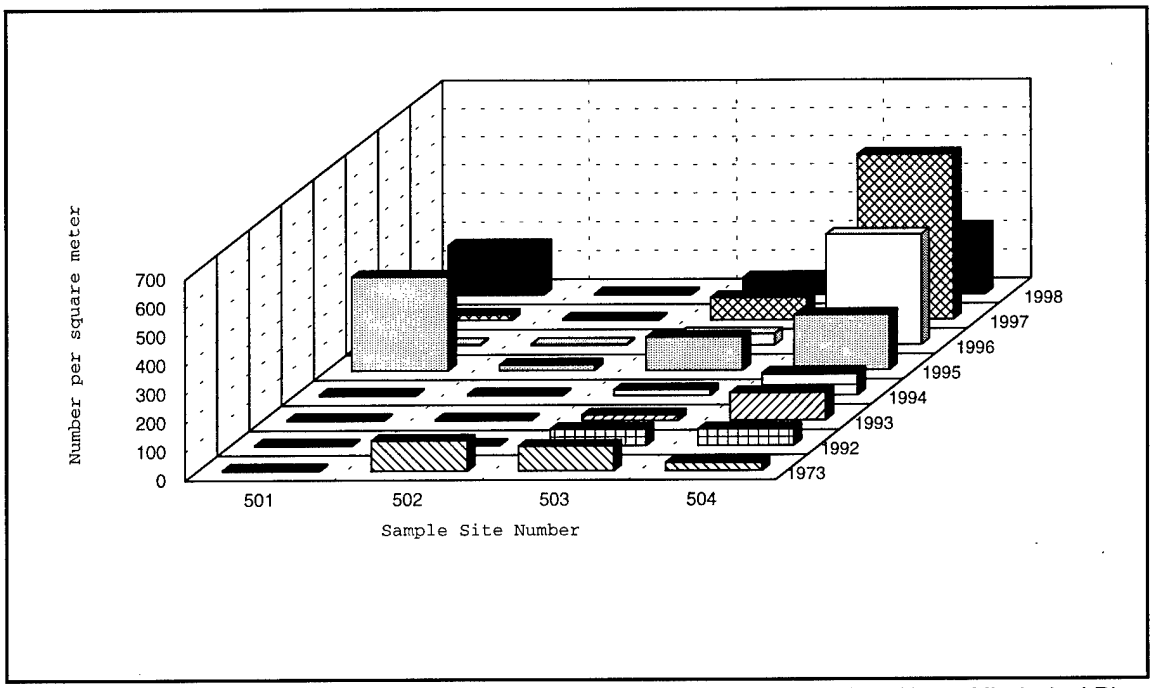

Figure 2. Abundance of mayflies (Ephemeroptera) at sites 501–504 in Pool 4 of the Upper Mississippi River System.

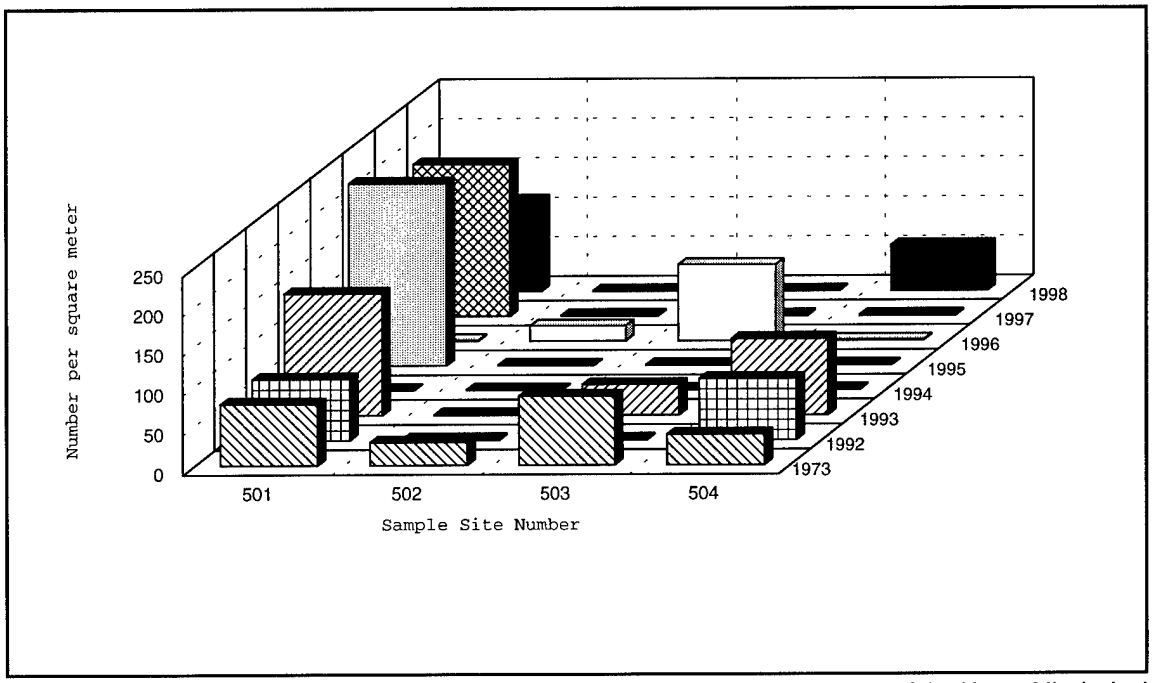

Figure 3. Abundance of fingernail clams (Sphaeriidae) at sites 501–504 in Pool 4 of the Upper Mississippi River System.

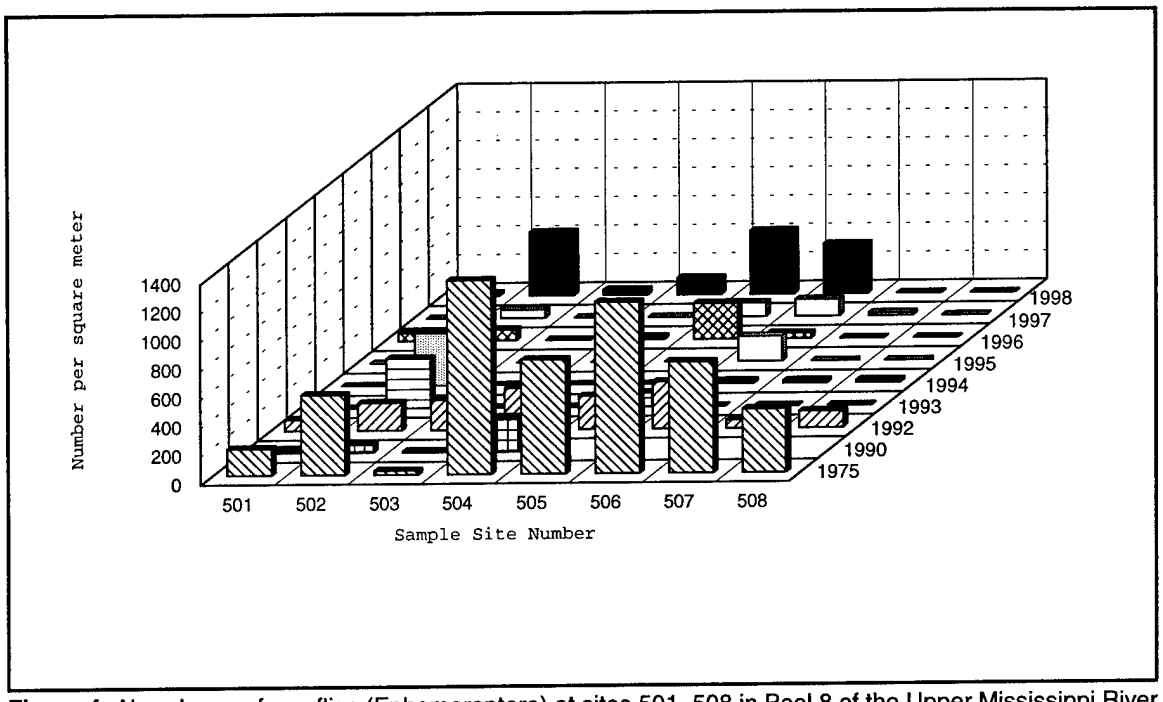

Figure 4. Abundance of mayflies (Ephemeroptera) at sites 501–508 in Pool 8 of the Upper Mississippi River System.

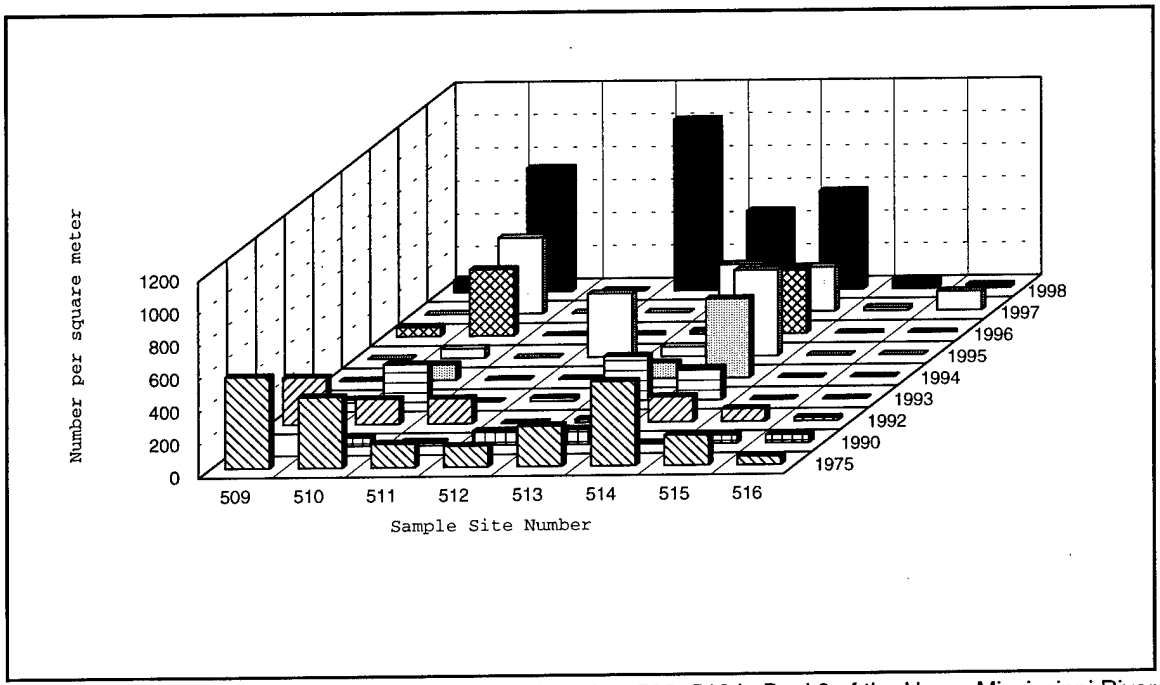

Figure 5. Abundance of mayflies (Ephemeroptera) at sites 509–516 in Pool 8 of the Upper Mississippi River System.

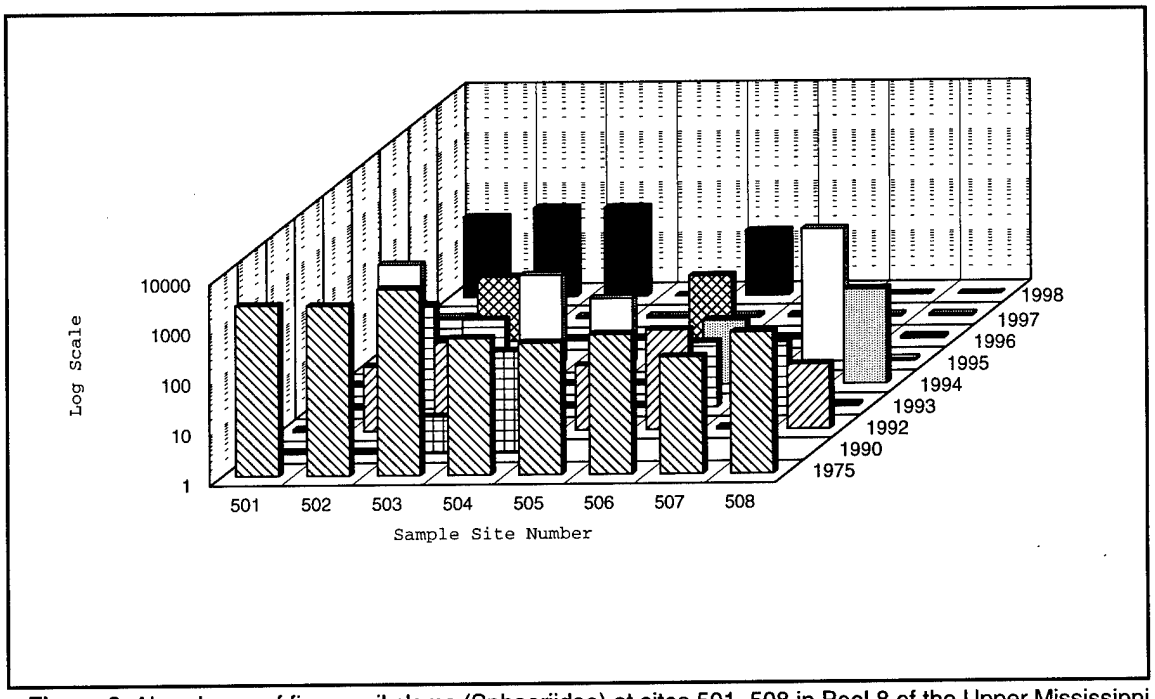

Figure 6. Abundance of fingernail clams (Sphaeriidae) at sites 501–508 in Pool 8 of the Upper Mississippi River System.

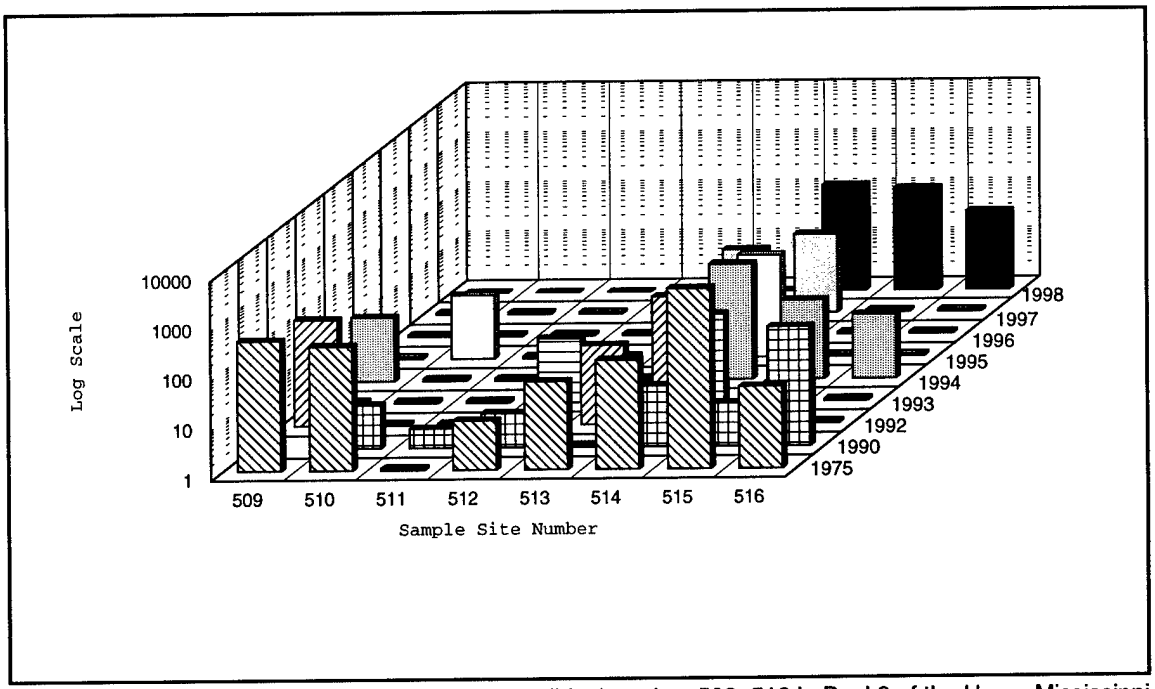

Figure 7. Abundance of fingernail clams (Sphaeriidae) at sites 509–516 in Pool 8 of the Upper Mississippi River System.

Pool 13

The highest number of mayflies and fingernail clams reported by Hubert et al. (1983) at sample sites in Pool 13 (Figures 8 and 9) from the present study was 1,017.4 m^{-2} (site 502; side channel area [SC]) and 1,544.6 m^{-2} (site 507; IMP), respectively. Between 1992 and 1998, the highest densities of mayflies and fingernail clams were 1,615.4 m^{-2} and 1,211.5 m^{-2} (site 503; SC), respectively. Over the years, the general distribution of mayflies was highest at sample sites 502–504—SC aquatic areas. Fingernail clam distribution was greatest in the IMP and SC aquatic areas.

In 1983, Hubert et al. found that lake habitats (N = 18) supported a mean of 66 m^{-2} *Hexagenia* and 295 m^{-2} Sphaerium. In three of the lake sites resampled by the LTRMP, mean densities of mayflies ranged from 121.8 to 528.5 m^{-2} and mean densities of fingernail clams ranged from 102.6 to 1,051.3 m^{-2}.

Pool 26

The highest number of mayflies and fingernail clams reported by Colbert et al. (1975) at sample sites in Pool 26 (Figures 10 and 11) from the present study was 172.0 m^{-2} (site 503; SC) and 25.0 m^{-2} (site 501; main channel border [MCB]), respectively. Between 1992 and 1998, the highest densities of mayflies and fingernail clams were 1,038.5 m^{-2} (site 503; SC) and 57.7 m^{-2} (site 507; SC), respectively. The general distribution of mayflies was highest at sample site 504, an SC aquatic area. Seagle et al. (1982) reported a *Hexagenia* density as high as 454 m^{-2} (N = 9; 5 replicates at each site). Of 37 samples taken over the years (1992–98), only 1 contained fingernail clams.

Open River

The highest number of mayflies reported by Emge et al. (1974) at sample sites in the Open River reach (Figures 12–15) from the present study was 675.0 m^{-2} (site 518; MCB). Between 1992 and 1998, the highest densities of mayflies was 384.6 m^{-2} (site 515; SC). Over the years, the general distribution of mayflies was highest at sample sites 515 and 518—SC and MCB aquatic areas, respectively. No sites contained fingernail clams.

La Grange Pool

The highest number of mayflies and fingernail clams reported by Anderson (1977) at sample sites 523–526 in La Grange Pool (Figures 16–19) was 34.4 m^{-2} (site 523; SC) and 34.4 m^{-2} (site 524; SC), respectively. Between 1992 and 1997, the highest densities of mayflies and fingernail clams were 173.0 m^{-2} (site 512; Quiver Lake) and 192.3 m^{-2} (site 523; SC), respectively. Over the years, the general distribution of mayflies was highest at sample sites in Quiver Lake. Fingernail clam distribution was also highest at the Quiver Lake area with a mean maximum of 17,201.9 m^{-2} in 1952, as reported by Paloumpis and Starrett (1960).

Richardson (1921) took benthic samples at Lake Matanzas in 1915 and found no *Hexagenia* mayfly nymphs and 225.7 m^{-2} fingernail clams in samples with depths between 6.5 and 8.5 feet and no vegetation, and 5.5 m^{-2} *Hexagenia* and 52.9 m^{-2} fingernail clams in samples with depths of 2 to 6 feet and some vegetation at all sites. Richardson also took samples in middle Quiver Lake and found *Hexagenia* densities less than 0.5 m^{-2} in 1914 and 1915 and fingernail clam densities of 42.0 m^{-2} in 1914 and 0.8 m^{-2} in 1915.

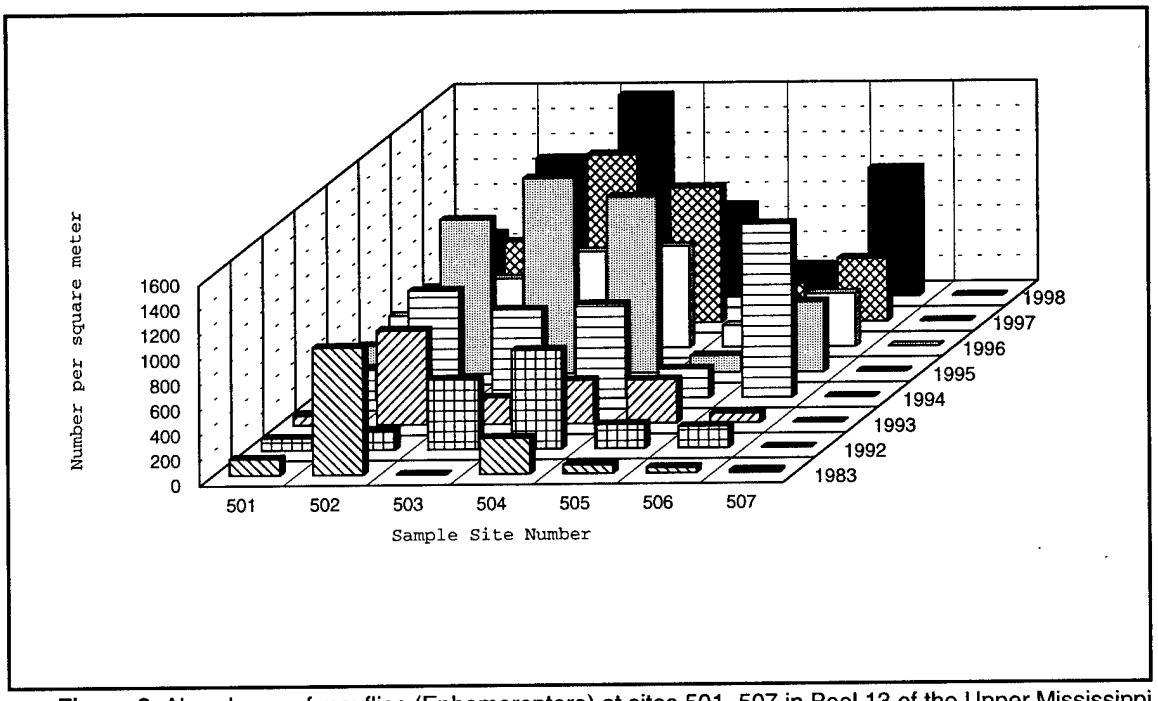

Figure 8. Abundance of mayflies (Ephemeroptera) at sites 501–507 in Pool 13 of the Upper Mississippi River System.

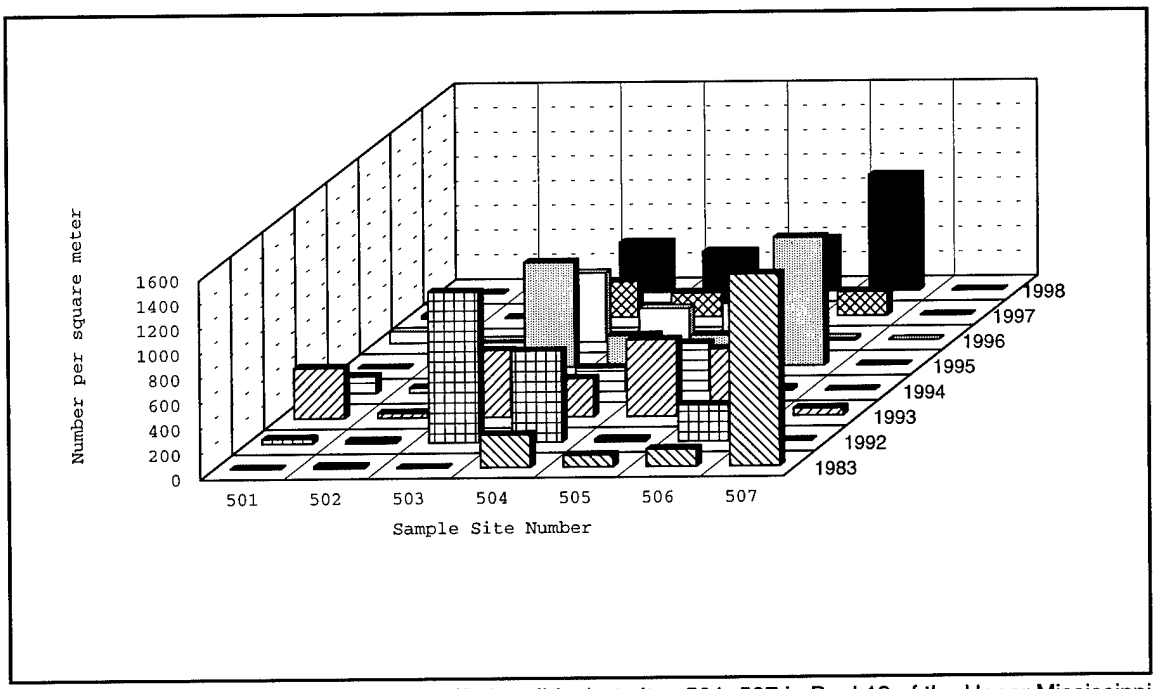

Figure 9. Abundance of fingernail clams (Sphaeriidae) at sites 501–507 in Pool 13 of the Upper Mississippi River System.

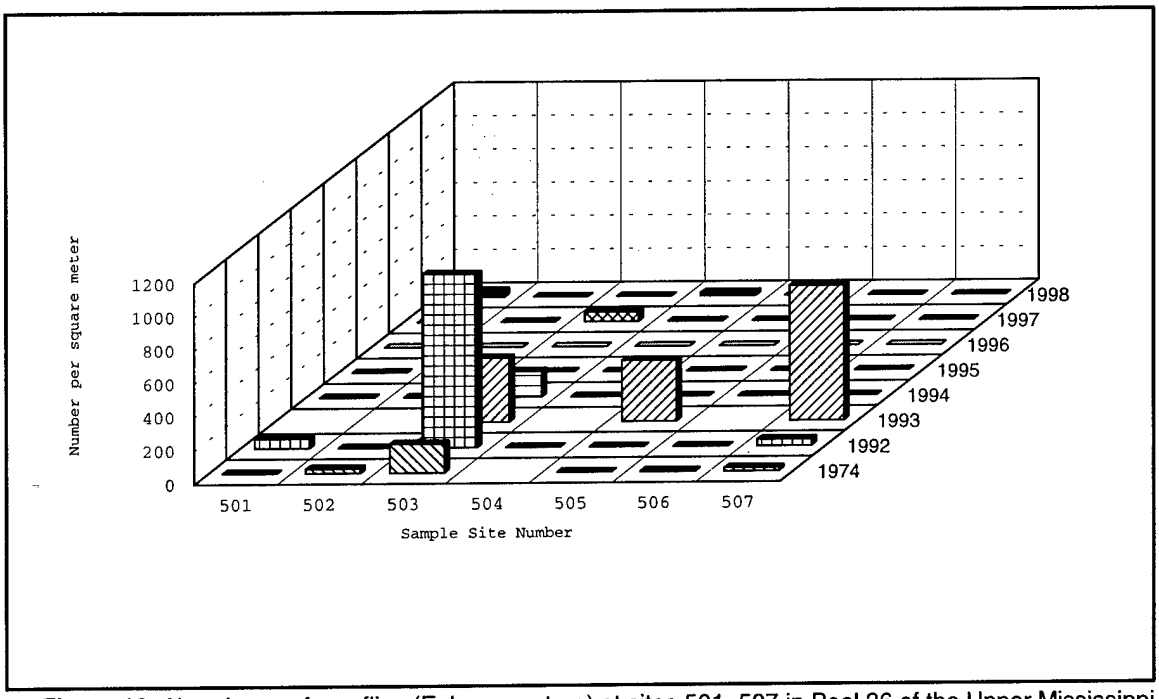

Figure 10. Abundance of mayflies (Ephemeroptera) at sites 501–507 in Pool 26 of the Upper Mississippi River System.

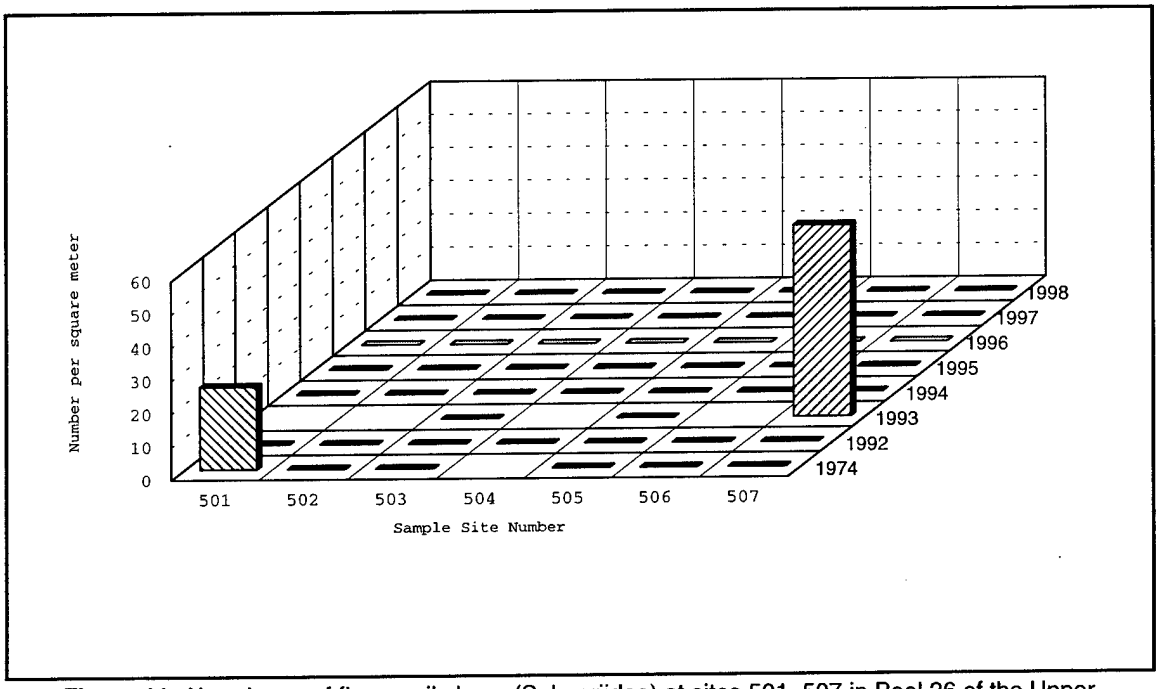

Figure 11. Abundance of fingernail clams (Sphaeriidae) at sites 501–507 in Pool 26 of the Upper Mississippi River System.

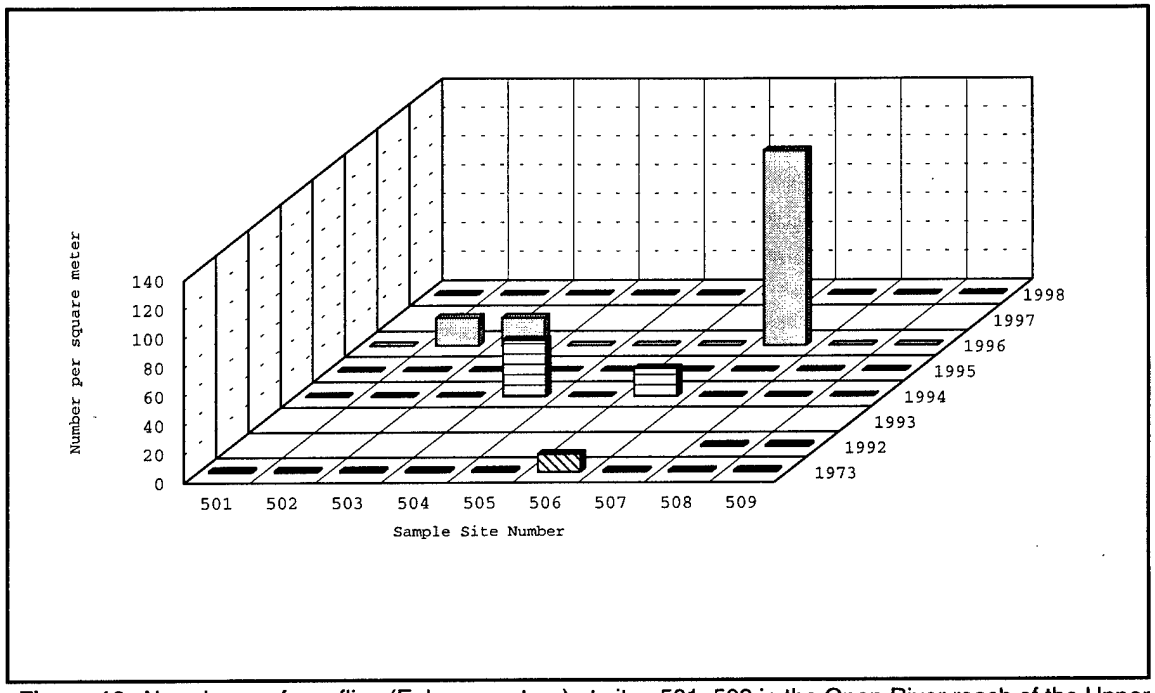

Figure 12. Abundance of mayflies (Ephemeroptera) at sites 501–509 in the Open River reach of the Upper Mississippi River System. Sites were not sampled in 1993 or 1997 because of flooding.

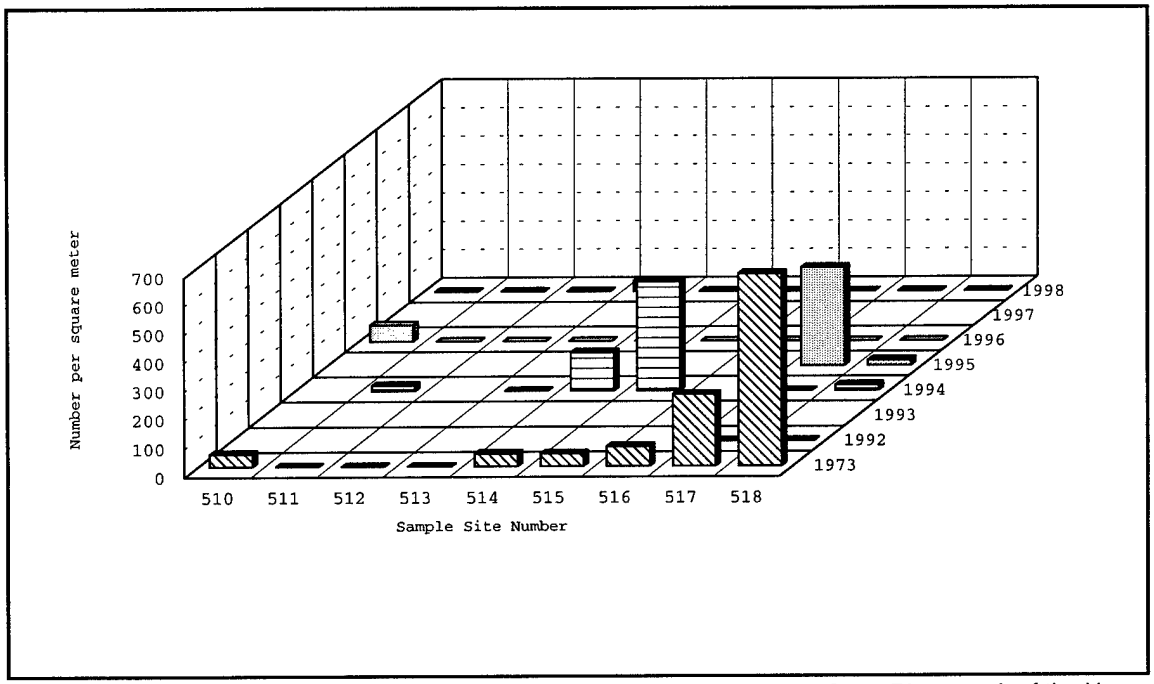

Figure 13. Abundance of mayflies (Ephemeroptera) at sites 510–518 in the Open River reach of the Upper Mississippi River System. Sites were not sampled in 1993 or 1997 because of flooding.

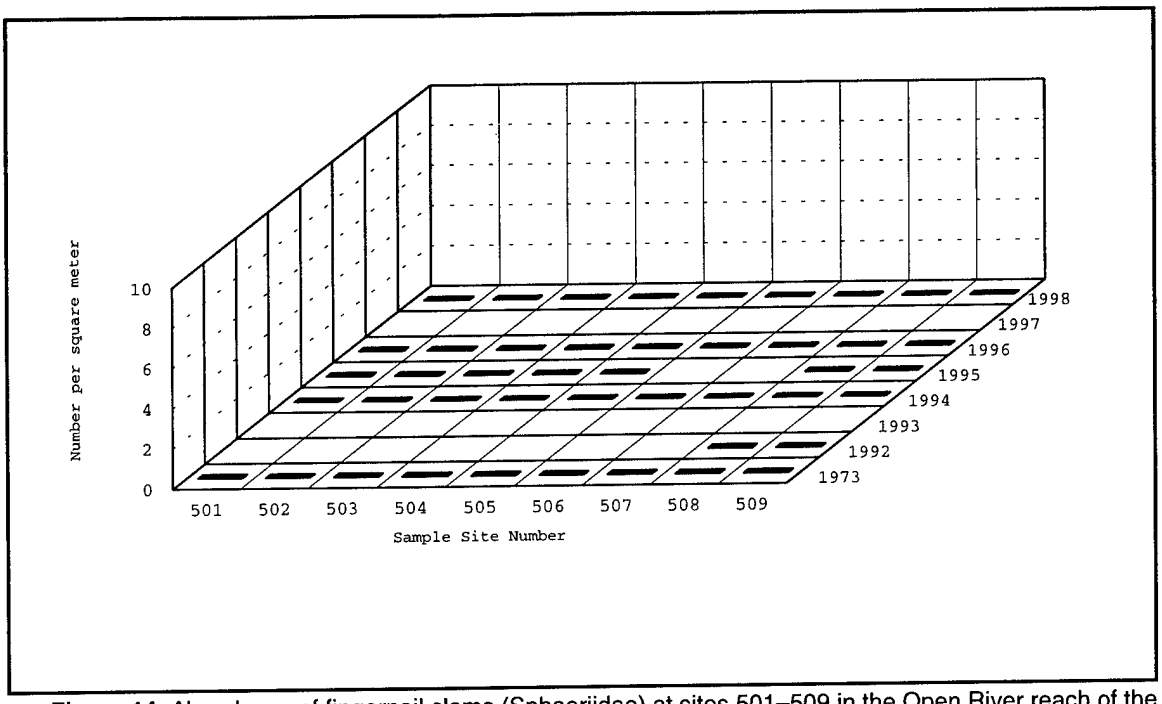

Figure 14. Abundance of fingernail clams (Sphaeriidae) at sites 501–509 in the Open River reach of the Upper Mississippi River System. Sites were not sampled in 1993 or 1997 because of flooding.

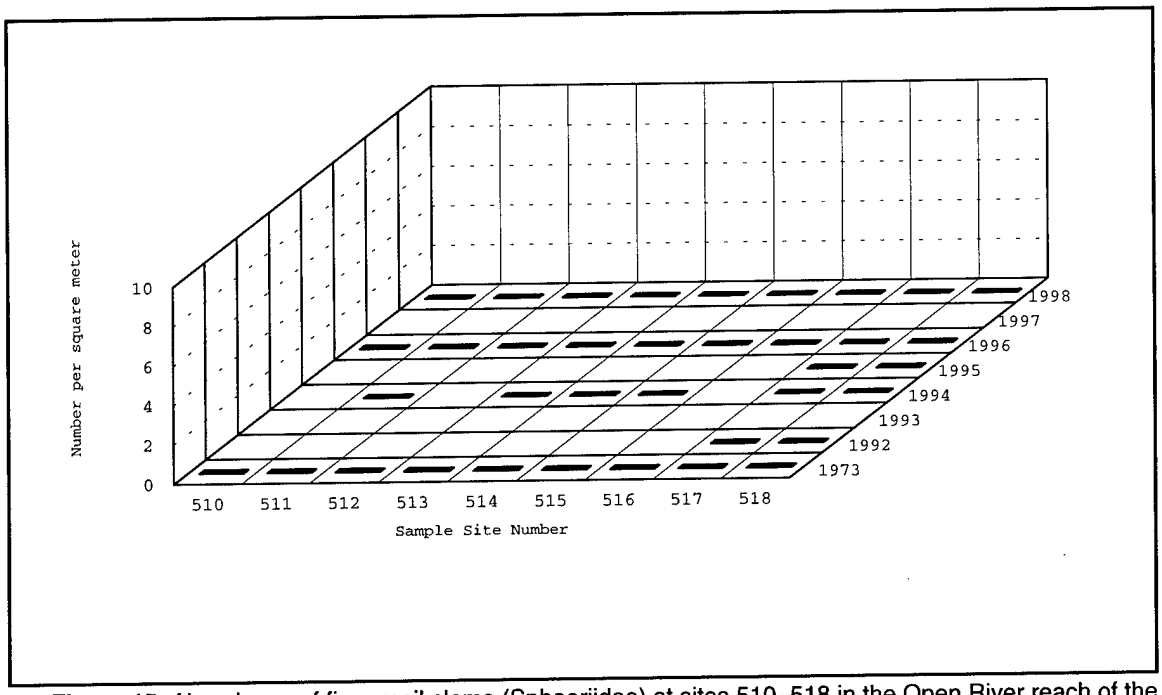

Figure 15. Abundance of fingernail clams (Sphaeriidae) at sites 510–518 in the Open River reach of the Upper Mississippi River System. Sites were not sampled in 1993 or 1997 because of flooding.

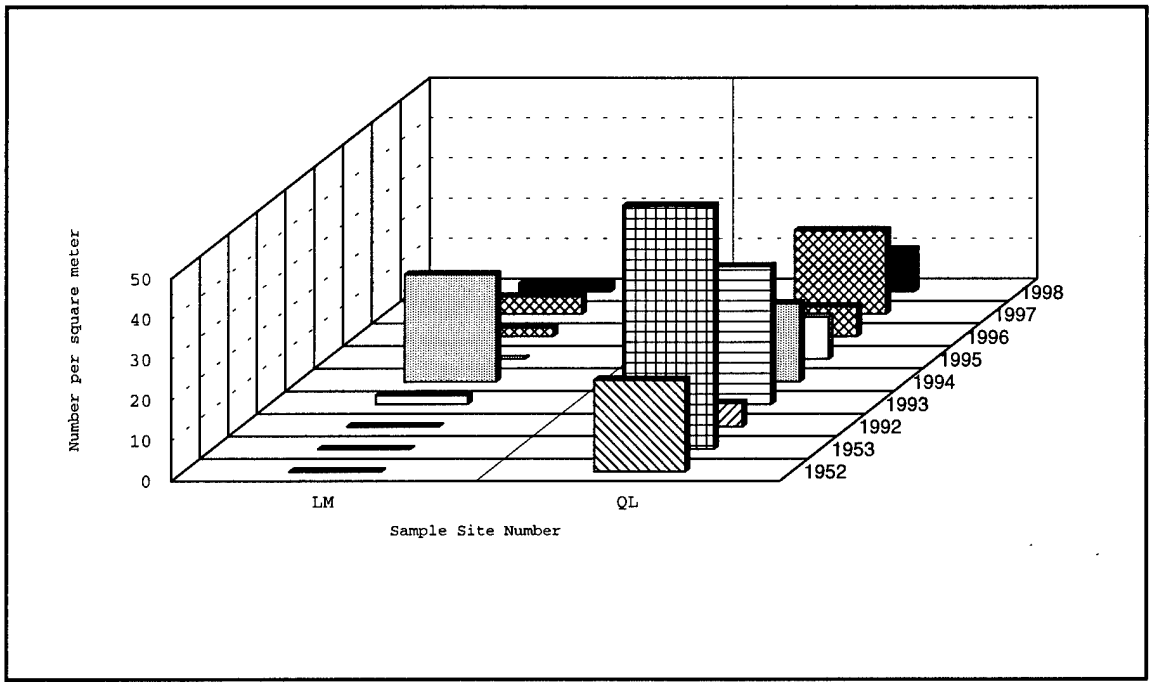

Figure 16. Abundance of mayflies (Ephemeroptera) at sites in Lake Matanzas (*LM*) and Quiver Lake (*QL*) in La Grange Pool of the Illinois River.

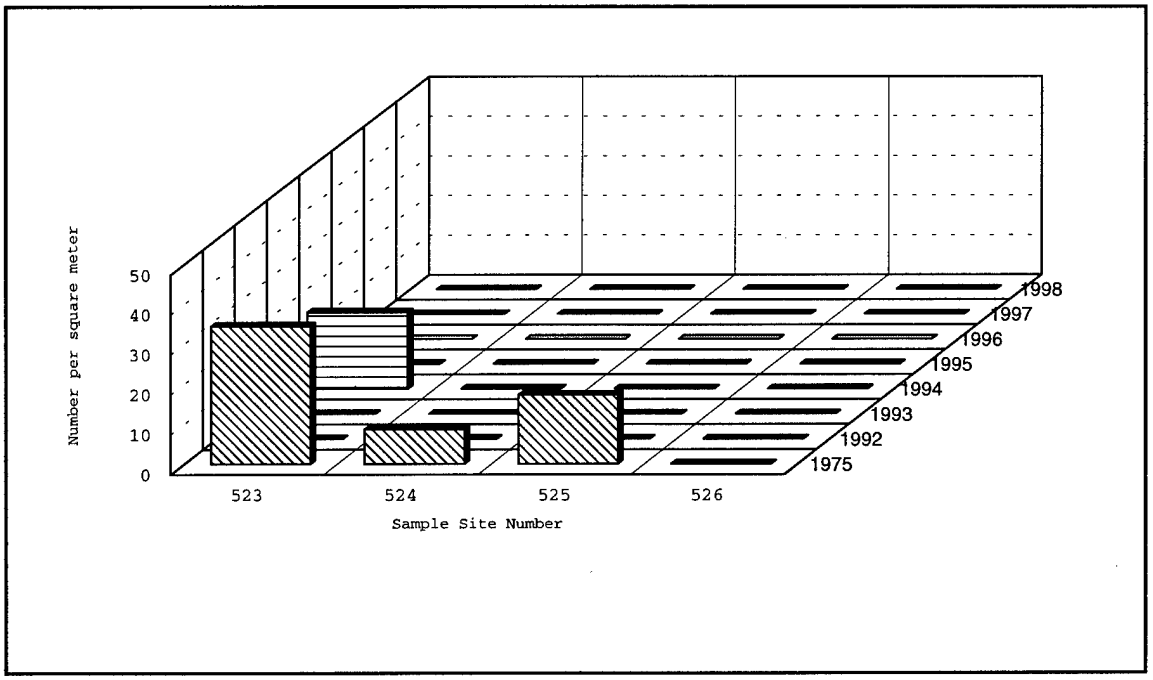

Figure 17. Abundance of mayflies (Ephemeroptera) at sites 523–526 in La Grange Pool of the Illinois River.

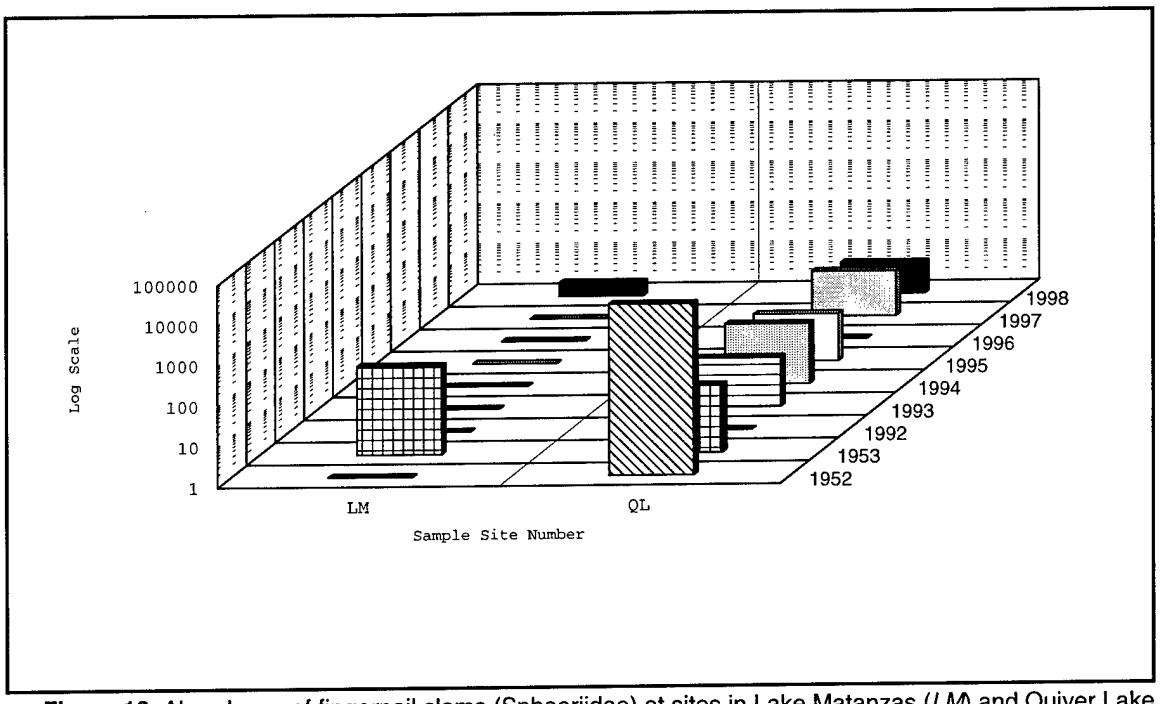

Figure 18. Abundance of fingernail clams (Sphaeriidae) at sites in Lake Matanzas (*LM*) and Quiver Lake (*QL*) in La Grange Pool of the Illinois River.

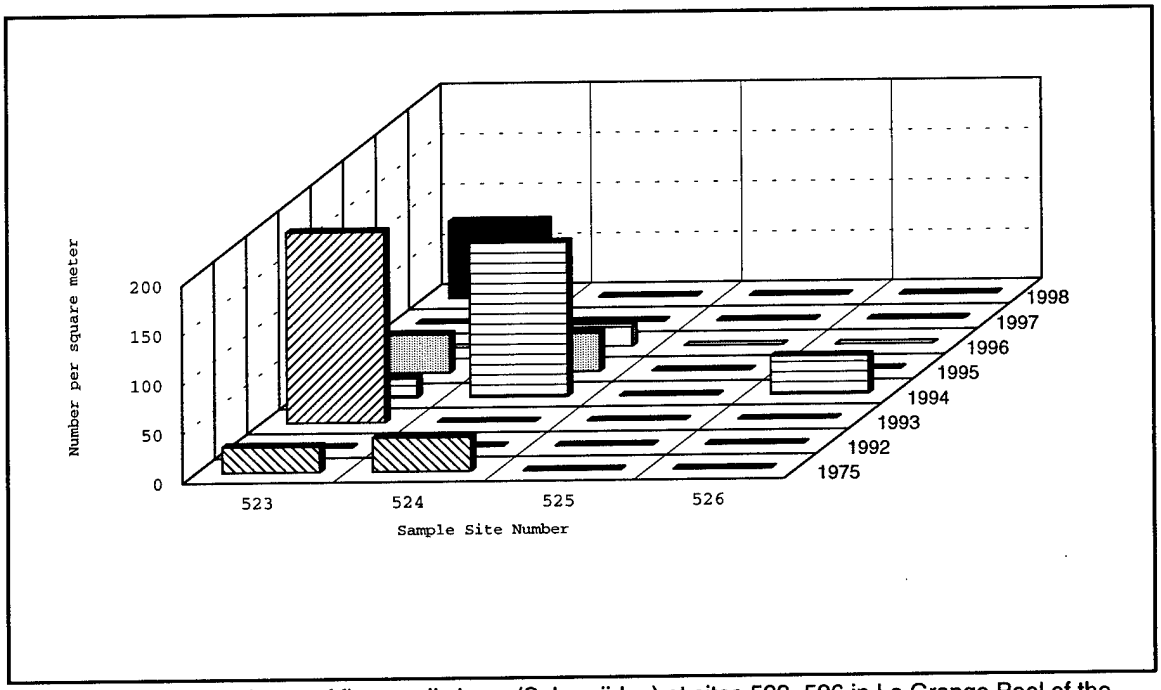

Figure 19. Abundance of fingernail clams (Sphaeriidae) at sites 523–526 in La Grange Pool of the Illinois River.

Summary

Even though we have limited historical data, these data combined with the LTRMP data can help us get an idea of the variation of mayfly and fingernail clam densities over the long term. Not surprisingly, yearly changes in organism abundance were noted at all sites in the study areas. Historically, Pools 8 and 13 had the highest density of mayflies at the sites sampled. The same pattern holds true under the LTRMP sampling. The mean density of mayflies increased in Pools 4, 13, and 26, while decreasing in the other study areas. Densities of fingernail clams declined in all study areas. Major declines in the densities of fingernail clams were seen in Pool 8 and La Grange Pool. Sandusky and Sparks (1979) found that elevated concentrations of ammonia may have been a partial cause of the decline of fingernail clams in Pool 19 in 1976–77. Ammonia concentrations may also have influenced the decline of fingernail clams in Pool 8 and La Grange Pool of the Illinois River. Declines were not as dramatic in Pools 4 and 13.

Before the decline of fingernail clams in the mid-1950s in the Illinois River, La Grange Pool contained the highest mean densities of fingernail clams at the sample sites, followed distantly by Pools 8 and 13. The Open River had no fingernail clams at the sample sites—past or present—probably because of a lack of suitable habitat in the Open River study area. Since LTRMP sampling began in 1992, Pool 13 fingernail clam densities far exceed those found in any of the other study areas.

Data from all study reaches combined showed that mayfly population trends were variable in the different aquatic areas sampled—densities increased in contiguous backwater, side channel, and tributary delta lake (Lake Pepin) aquatic areas and decreased in impounded areas and main channel borders. Fingernail clam densities declined in all aquatic areas sampled, except for side channel aquatic areas where they increased in mean densities from past to present.

Acknowledgments

The Long Term Resource Monitoring Program is a cooperative effort by the Biological Resources Division of the U.S. Geological Survey, the U.S. Army Corps of Engineers, the Minnesota Department of Natural Resources, the Illinois Department of Conservation, the Illinois Natural History Survey, the Iowa Department of Natural Resources, the Missouri Department of Conservation, and the Wisconsin Department of Natural Resources. Monitoring is conducted by the participating State resource management and research agencies. Thanks go to these agencies and field station staff, especially Tim Mihuc, Illinois Department of Natural Resources, for his comments on this report.

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Appendix. Sampling Sites

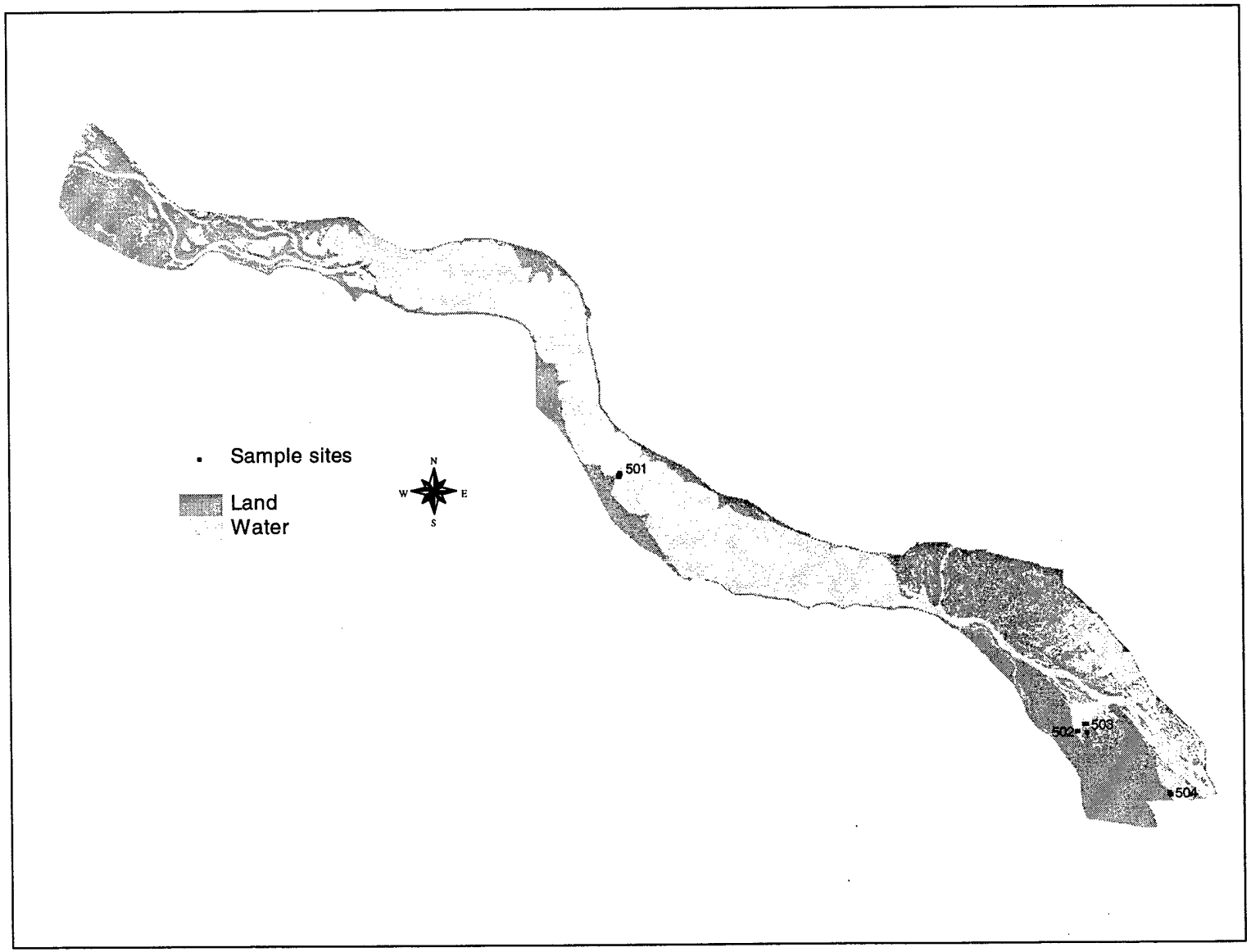

Figure A-1. Pool 4 Long Term Resource Monitoring Program historical macroinvertebrate sample sites.

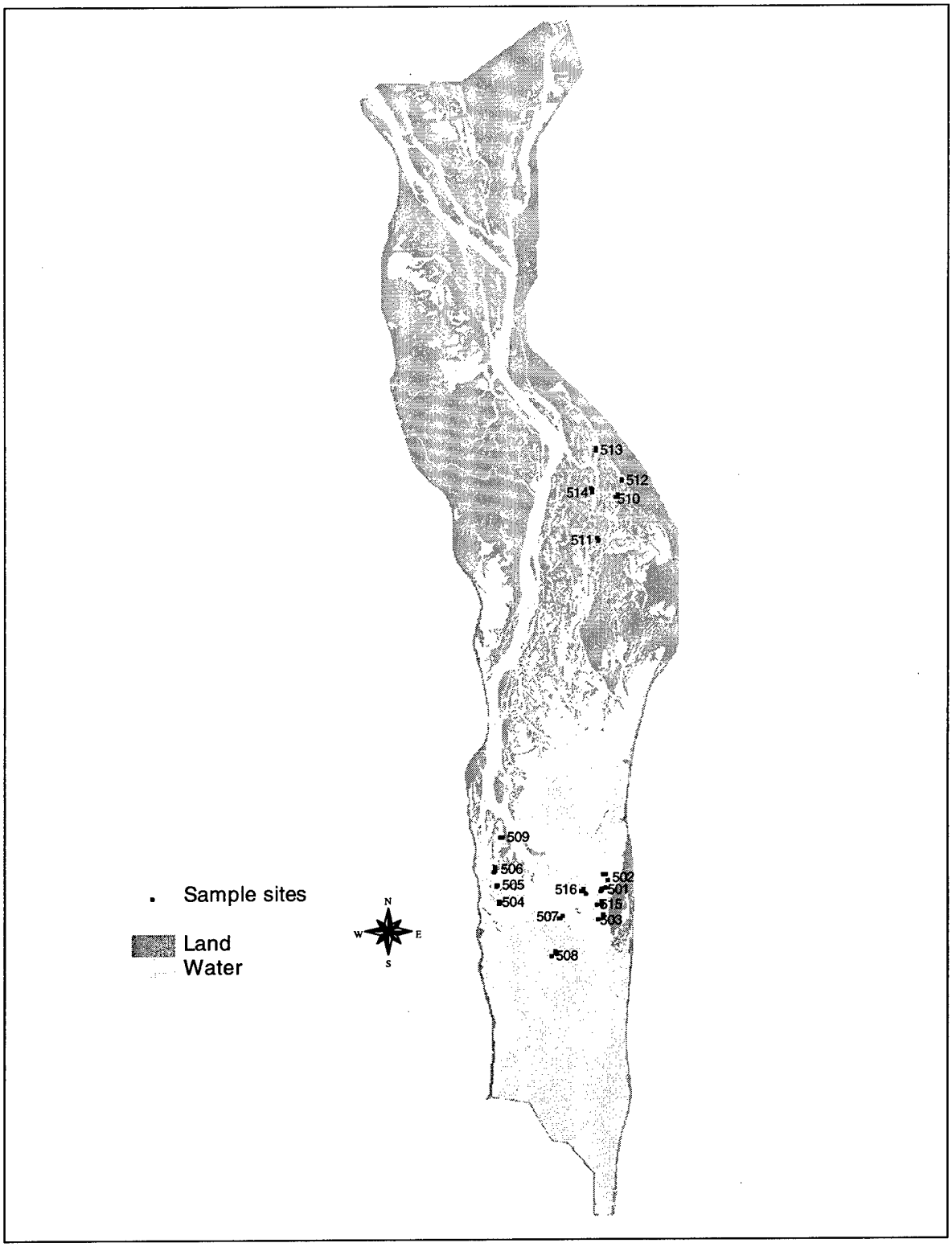

Figure A-2. Pool 8 Long Term Resource Monitoring Program historical macroinvertebrate sample sites.

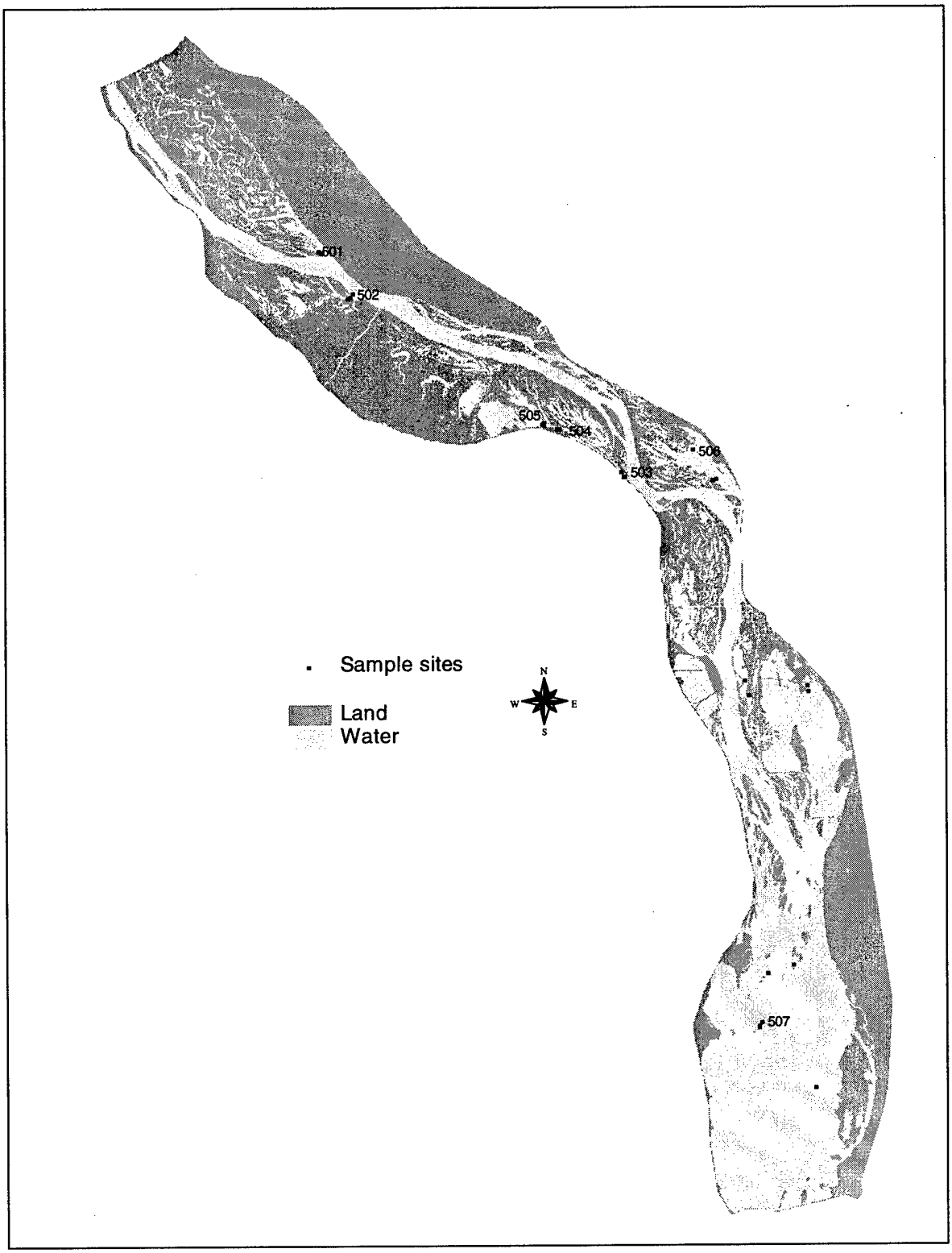

Figure A-3. Pool 13 Long Term Resource Monitoring Program historical macroinvertebrate sample sites.

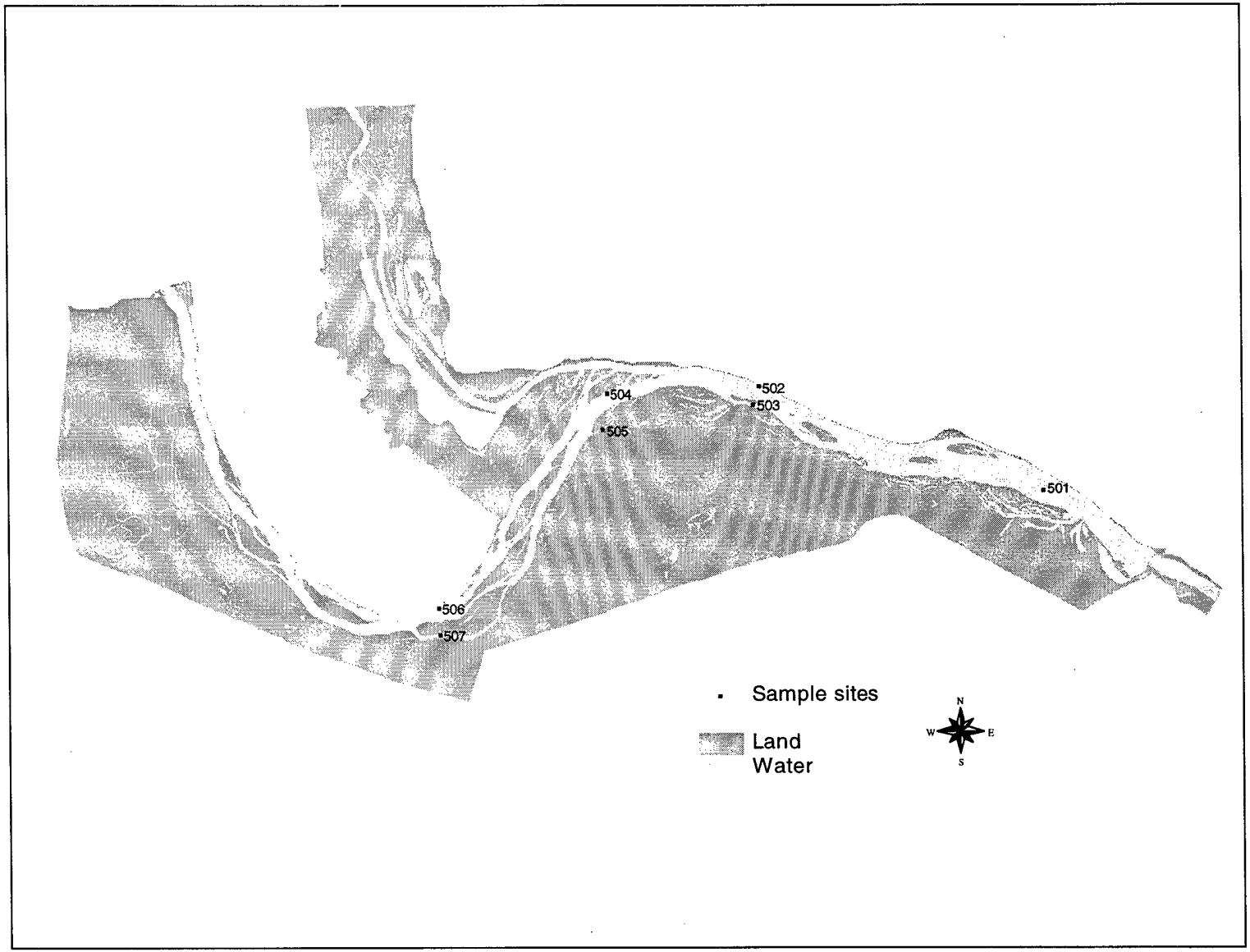

Figure A-4. Pool 26 Long Term Resource Monitoring Program historical macroinvertebrate sample sites.

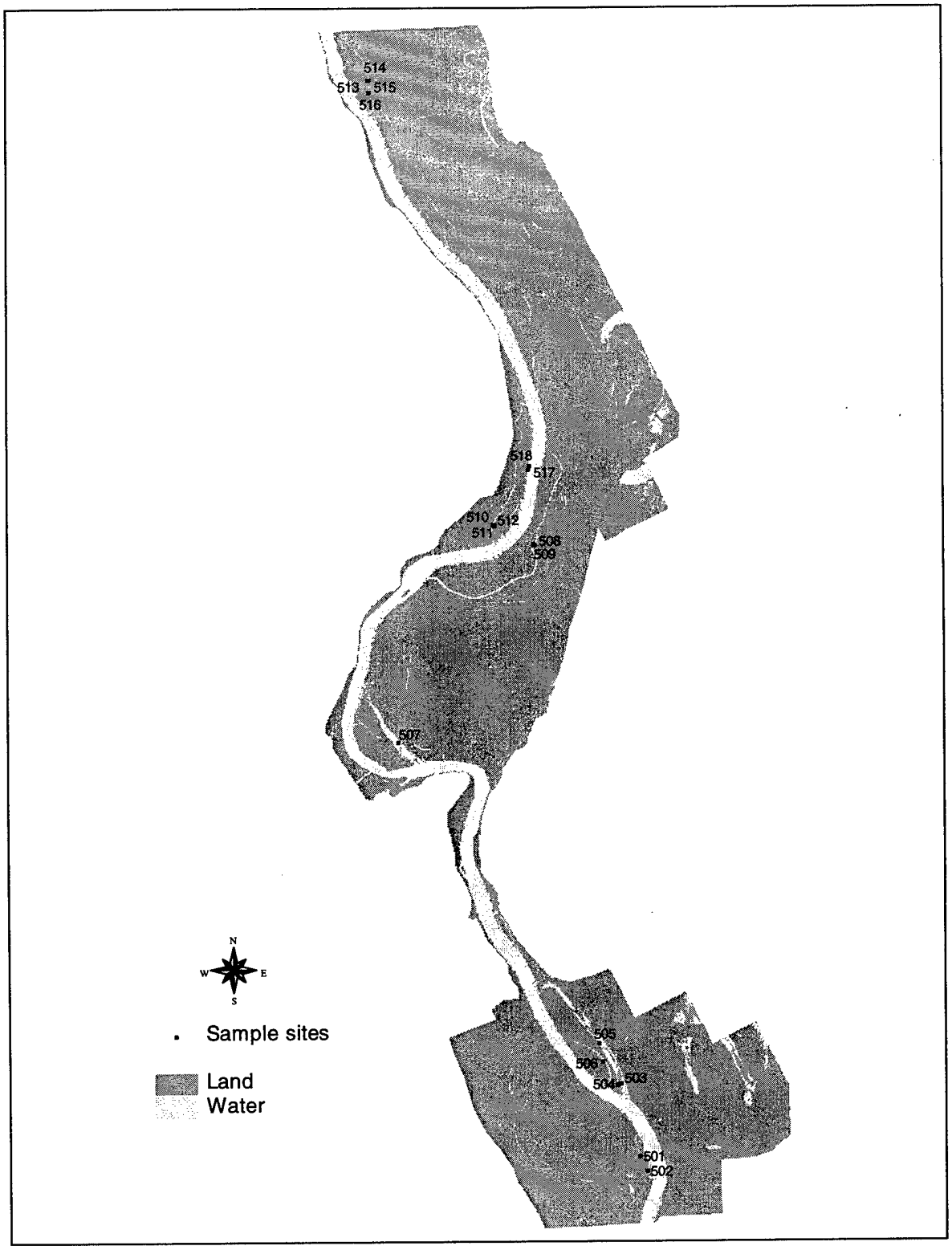

Figure A-5. Open River Long Term Resource Monitoring Program historical macroinvertebrate sample sites.

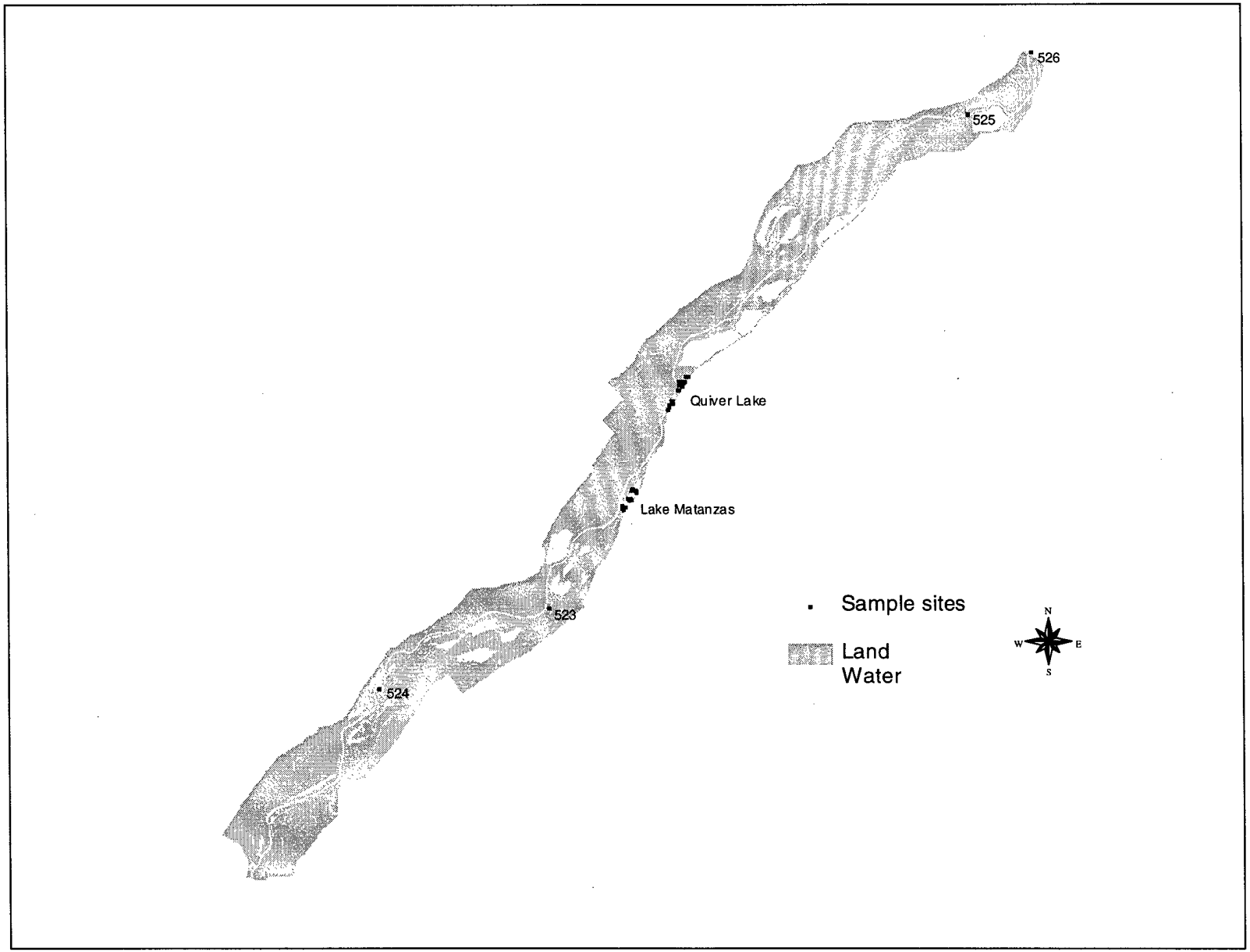

Figure A-6. La Grange Pool Long Term Resource Monitoring Program historical macroinvertebrate sample sites.

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The Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System was authorized under the Water Resources Development Act of 1986 as an element of the Environmental Management Program. The mission of the LTRMP is to provide river managers with information for maintaining the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character. The LTRMP is a cooperative effort by the U.S. Geological Survey, the U.S. Army Corps of Engineers, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.